UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/887,490	06/22/2001	Lior Ophir	TI-30916	7722

23494 7590 09/19/2005

TEXAS INSTRUMENTS INCORPORATED
P O BOX 655474, M/S 3999
DALLAS, TX 75265

EXAMINER	
AHN, SAM K	

ART UNIT	PAPER NUMBER
2637	

DATE MAILED: 09/19/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/887,490	OPHIR ET AL.	
	Examiner	Art Unit	
	Sam K. Ahn	2637	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 September 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-45 and 47-49* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20,22-24,26-45 and 47-49* is/are rejected.

7)☒ Claim(s) *21 and 25* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 January 2005* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 09/01/05 has been entered.

Drawings

2. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the claim limitation recited in claim 5 of *"partitioning a signal constellation into cosets and shells in compliance with a shell mapping and the TTCM encoder"* must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Claim 5 appears to be reciting a Shell Mapper, illustrated in Fig.7, while its independent claim 1 appears to reciting Fig.2. Drawing does not illustrate the combination of having cosets and shells.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended."

If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

3. Claims 47 and 48 are objected to because of the following informalities:

Claims 47 and 48 are depending on a cancelled claim 46. The office action is based on an assumption that the claims are depending on claim 45.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 5 and 40-44 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Claims 5 and 40 recite "shell mapper" while its independent claims of 1 and 26 recite "coset representative generator". The specification does not describe in such a way as to enable one skilled in the art how the two elements could be combined into one embodiment. Claims 41-44 directly or indirectly depend on claim 41.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1-4,6-17,26-38 and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eyuboglu et al. (Eyuboglu, Trellis Precoding, cited in IDS no. CE, received on 05/23/02) in view of Gelblum et al. USP, 6,088,387 (Gelblum, cited previously).

Regarding claims 1, 26 and 28, Eyuboglu teaches a method and apparatus of binary coded data communication, the method comprising the steps of providing a transmitter having a trellis coded modulator (TCM, note p.304, second

paragraph) encoder and constellation shaping elements (MAP, in Fig.5), a receiver having a receiver turbo decoder, and receiver constellation shaping elements (see Fig.6); However, Eyuboglu does not teach wherein the trellis coded modulator is a turbo trellis coded modulator. Eyuboglu further teaches dividing a desired symbol sequence into a binary k_c-tuple, an uncoded binary n_u-tuple, and a syndrome r_s-tuple (as illustrated in Fig.5); processing the binary k_c-tuple of the desired symbol sequence via the TCM encoder for a rate k_c/n_c TCM code to generate a n_c-tuple (by the G_c block); processing the syndrome r_s-tuple of the desired symbol sequence via a coset representative generator for a rate $k_s = n_s - r_s$ to generate a n_s-tuple (by the $(H_s^{-1})^T$ block, and note p.304, third paragraph); and processing the uncoded binary n_u-tuple of the desired symbol sequence, the output of the TCM encoder (output of Gc block), and the output of the coset respresentative generator (output of $(H_s^{-1})^T$ block) for a rate k_s/n_s Convolutional shaping code via a decoder (Decoder for Cs and an adder) to generate a desired bit sequence, wherein k and n are integers. However, Eyuboglu does not explicitly teach wherein the TCM is a a turbo-trellis code modulation (TTCM) encoder.

Gelblum teaches combining turbo codes with a trellis code modulation and discloses a turbo-trellis code modulation (TTCM) (see Fig.1). And further teaches that TTCM achieves low bit error rate (BER). (note col.1, line 13 – col.2, line 62) Therefore, it would have been obvious to one skilled in the art at the time of the invention to modify Eyuboglu's TCM with TTCM for the purpose of

achieving a higher BER, and furthermore, TCM and TTCM belong to same family of trellis modulation.

Regarding claim 2, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 1. Eyuboglu further teaches wherein the step of generating a plurality of signal points in response to a partitioned binary coded symbol sequence that is processed via the TTCM encoder and constellation shaping elements comprises the step of generating a signal constellation having square shaping regions (see Fig.4) capable of use in association with trellis shaping that is compatible with rate kc/nc TTCM, such that a binary kc -tuple portion of a desired symbol sequence can be processed via the TTCM encoder for a rate kc/nc TTCM code to generate a nc -tuple.

Regarding claim 3, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 1. Eyuboglu further teaches wherein the step of generating a plurality of signal points in response to a partitioned binary coded symbol sequence that is processed via the TTCM encoder and constellation spherical elements comprises the step of generating a signal constellation having square shaping regions capable of use in association with trellis shaping that is compatible with rate kc/nc TTCM, such that a binary kc -tuple portion of a desired symbol sequence can be processed via the TTCM encoder for a rate kc/nc TTCM code to generate a nc -tuple. (see Fig.14 and note p.311)

Regarding claims 4,33 and 38, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 1 or 29. Eyuboglu further teaches wherein the step of providing a transmitter having a turbo trellis coded modulator (TTCM) encoder and constellation shaping elements comprises the step of providing trellis precoding elements and TH-precoding elements capable of use with non-square constellations. (see Fig.8 and note p.306-308)

Regarding claims 6 and 29, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 1 or 28. Eyuboglu further teaches processing the desired bit sequence and the output of the coset representative generator for the rate ks/ns convolutional shaping code via a combinational element to generate a selected bit sequence (n_s, output of adder), and mapping (by MAP) the selected bit sequence (n_s, output of adder), the uncoded binary nu-tuple of the desired symbol sequence, and the output of the TTCM encoder (n_c-tuple) to generate the plurality of signal points, w(D).

Regarding claim 7, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 6. Eyuboglu further teaches providing a receiver turbo decoder (Decoder in Fig.6) and receiver constellation shaping elements, Gc^{-1}, H_s^T, and processing the plurality of signal points via the receiver turbo decoder

and the receiver constellation shaping elements to recover the partitioned binary coded symbol sequence (outputting k_c-tuple, n_c-tuple and r_s-tuple).

Regarding claims 8-11, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 7. The further limitations are the reverse order of the steps performed at the transmitter. Thus, in order to receive and recover the data, the system of Eyuboglu in view of Gelblum performs the reverse steps, which is well-known in the art to one skilled in the art.

Regarding claim 12, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 1. Eyuboglu further teaches the step of processing the plurality of siral points via a trellis precoder to generate a coded symbol sequence. (see Fig.7 and 8)

Regarding claims 13,14 and 27, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 12 or 26. Eyuboglu further teaches providing a receiver having a turbo decoder and constellation shaping elements, and processing the plurality of signal points via the receiver turbo decoder and the receiver constellation shaping elements to recover the partitioned symbol sequence. (see Fig.6 and note p.304 fifth paragraph of having a nonuniform probability distribution)

Regarding claims 15 and 34, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 12 or 33. Eyuboglu further teaches wherein the step of processing the plurality of signal points via the receiver turbo decoder and the receiver constellation shaping elements comprises the steps of: folding the coded symbol sequence to generate a folded constellation (see Folding in Fig.9); processing the folded constellation via the turbo decoder to generate estimated signal points (see Decoder in Fig.9); and processing the estimated signal points via an inverse mapper to generate an estimated binary kc -tuple part of the desired bit sequence according to the rate kc/nc TTCM code, an estimated uncoded binary nu -tuple part of the desired symbol sequence, and an estimated binary rs -tuple part of the desired bit sequence according to the rate ks/ns convolutional shaping code. (see Fig.6)

Regarding claims 16,17,30-32 and 35-37, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 15. Eyuboglu further teaches wherein the step of processing the plurality of signal points via the receiver turbo decoder and the receiver constellation shaping elements further comprises the step of processing the estimated binary kc -tuple part of the desired bit sequence according to the rate kcjnc TTCM code to recover k bits based on n bits and to generate an estimated binary kc -tuple part of the desired symbol sequence, and the step of processing the estimated binary rs -tuple part of the desired bit

sequence according to the rate ks/ns convolutional shaping code to generate an estimated syndrome rs -tuple part of the desired spnbol sequence. (see Fig.6)

Regarding claim 38, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 28. Eyuboglu further teaches wherein the trellis precoder comprises a Tomlinson-Harashima precoder. (note p.305)

Regarding claim 49, Eyuboglu in view of Gelblum teach all subject matter claimed, as applied to claim 26. Eyuboglu further teaches wherein the constellation shaping elements comprise trellis shaping elements (note p.305, first paragraph and see Fig.6), wherein the further limitations are explained previously.

6. Claims 45,47 and 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eyuboglu et al. (Eyuboglu, Trellis Precoding, cited in IDS no. CE, received on 05/23/02) in view of Gelblum et al. USP, 6,088,387 (Gelblum, cited previously) and Cohen et al. USP 6,111,912 (Cohen).

Regarding claims 45,47 and 48, Eyuboglu teaches a method of binary coded data communication, the method comprising the steps of providing a transmitter having a trellis coded modulator (TCM) encoder and constellation shaping elements, a receiver having a receiver turbo decoder, and receiver constellation shaping elements (see Fig.6); and generating a plurality of signal points in

response to a partitioned binary coded symbol sequence that is processed via the TCM encoder and constellation shaping elements. (see Fig.5 and note p.303-305) Eyuboglu further teaches providing a receiver having a turbo decoder and constellation shaping elements, and processing the plurality of signal points via the receiver turbo decoder and the receiver constellation shaping elements to recover the partitioned symbol sequence. (see Fig.6 and note p.304 having a nonuniform probability distribution)

However, Eyuboglu does not teach wherein the trellis coded modulator is a turbo trellis coded modulator. Gelblum teaches combining turbo codes with a trellis code modulation and discloses a turbo-trellis code modulation (TTCM) (see Fig.1). And further teaches that TTCM achieves low bit error rate (BER). (note col.1, line 13 – col.2, line 62) Therefore, it would have been obvious to one skilled in the art at the time of the invention to modify Eyuboglu's TCM with TTCM for the purpose of achieving a higher BER, and furthermore, TCM and TTCM belong to same family of trellis modulation.

However, Eyuboglu in view of Gelblum do not explicitly teach wherein the step of processing a plurality of signal points via the TTCM decoder comprises a step of computing in each iteration, a likelihood ratio for each data bit, which equals a ratio between a probability a bit is a '1' and the probability is a '0'.

Cohen teaches wherein the step of processing a plurality of signal points via the TTCM decoder comprises a step of computing in each iteration, a likelihood ratio for each data bit, which equals a ratio between a probability a bit is a '1' and the

probability is a '0' by generating a symbol distribution histogram (note col.4, lines 44-52 and col.5, lines 42-55). Therefore, it would have been obvious to one skilled in the art at the time of the invention to incorporate the teaching of Cohen in the system of Eyuboglu by performing the step of computing, as explained above, for the purpose of effectively determining the data rates, as taught by Cohen (note col.2, lines 14-18).

7. Claims 5 and 39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eyuboglu (cited no.CE in the IDS) in view of Gelblum et al. USP, 6,088,387 (Gelblum) and in further view of Khandani (Shaping of Multi-dimensional Signal Constellations Using a Lookup Table, cited previously), IEEE.

Regarding claims 5 and 39, Eyuboglu in view of Gelblum and Forney teach all subject matter claimed, as applied to claim 1 or 26. Eyuboglu in view of Gelblum further teaches wherein the step of generating a plurality of signal points in response to a partitioned binary coded symbol sequence that is processes via the TTCM encoder and constellation shaping elements, however, do not explicitly teach partitioning a signal constellation into cosets and shells in compliance with shell mapping and TTCM. Khandani teaches teach partitioning a signal constellation into cosets and shells in compliance with shell mapping and TCM. (see Fig.1 and note p.0927-0928) Therefore, it would have been obvious to one skilled in the art at the time of the invention to modify Eyuboglu's system by replacing Eyuboglu's constellation shaping elements with a shell mapper of

Khandani for the purpose of increasing average energy, as taught by Khandani (note p.0928).

8. Claims 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Long USP 5,926,505 in view of Gelblum et al. USP, 6,088,387 (Gelblum, cited previously) and Forney, Jr. et al. USP 5,150,381 (Forney, cited previously).

Regarding claim 18, Long teaches a method of binary coded data communication comprising: providing a transmitter (see Fig.3) having a trellis coded modulator encoder (304) and constellation shaping elements (303); dividing a desired symbol sequence into a first part, second part and third part (S1... Sk, I1~I3 and Q1~Q3); processing the first part of the desired symbol sequence via a shell mapper (303, note col.3, lines 41-43) to generate N shells; processing the second part of the desired symbol sequence via the TCM encoder (304) to generate N cosets; and mapping (305) the third part of the desired symbol sequence, the N shells, and the N cosets to generate N transmit symbols (output of 305).

However, Long does not explicitly teach wherein the trellis coded modulator is a turbo trellis coded modulator. Gelblum teaches combining turbo codes with a trellis code modulation and discloses a turbo-trellis code modulation (TTCM) (see Fig.1). And further teaches that TTCM achieves low bit error rate (BER). (note col.1, line 13 – col.2, line 62) Therefore, it would have been obvious to one skilled in the art at the time of the invention to modify Eyuboglu's TCM with

TTCM for the purpose of achieving a higher BER, and furthermore, TCM and TTCM belong to same family of trellis modulation.

However, Long in view of Gelblum do not explicitly teach the first, second and third part having K, N*k and remaining bits, respectively.

Forney teaches, in the same field of endeavor, wherein the partitioned symbol sequence (see Fig.13) comprises a first part having K-bits (3 bits), a second part having N*k – bits (1*3), and a third part having the remaining bits (2m) and wherein K and N are integers. Therefore, it would have been obvious to one skilled in the art at the time of the invention to input the partitioned symbol sequence in the system of Long in view of Gelblum for the purpose of having a bit structure to support Wei code, which has a good practical characteristics and achieving a good shaping gain, as taught by Forney (note col.26, lines 49-65 and note col.27, line 48-54).

Regarding claims 19 and 20, Long in view of Gelblum and Forney teach all subject matter claimed, as applied to claim 18. The further limitation recited is a reverse operation performed at a receiver, thus, one skilled in the art at the time of the invention would analyze that the receiver of Long would be performing the reverse operation of the steps performed at the transmitter, which is well-known to one skilled in the art at the time of the invention for the purpose of properly detecting received signals. The further limitation of the turbo decoder using a non

equi-probable symbol distribution is well-known to one skilled in the art where two dimensional constellation has a certain distribution.

9. Claims 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Long USP 5,926,505 in view of Gelblum et al. USP, 6,088,387 (Gelblum, cited previously) and Forney, Jr. et al. USP 5,150,381 (Forney, cited previously) in further view of Laroia (Coding for ISI Channels- combined Coding and Precoding).

Regarding claim 22, Long in view of Gelblum and Forney teach all subject matter claimed, as applied to claim 18. However, Long in view of Gelblum and Forney do not explicitly teach step of processing the N symbols via a Laroria precoder to generate a precoded symbol sequence.

Laroia teaches the Laroia precoder (in Fig.5, note p.1056 fifth paragraph) receiving N symbols, a_n, to generate a precoded symbol sequence, b_n.

Therefore, it would have been obvious to one skilled in the art at the time of the invention to incorporate the teaching of Laroia in the system of Long by coupling the output of the encoder to the Laroia precoder, as taught by Laroia, for the purpose of combating intersymbol interference, as taught by Laroia (note p.1056 fifth paragraph).

Regarding claims 23 and 24, Long in view of Gelblum and Forney in further view of Laroia teach all subject matter claimed, as applied to claim 18. The further limitation recited is a reverse operation performed at a receiver, thus, one skilled

in the art at the time of the invention would analyze that the receiver of Long would be performing the reverse operation of the steps performed at the transmitter, which is well-known to one skilled in the art at the time of the invention for the purpose of properly detecting received signals.

The further limitation of the turbo decoder using a non equi-probable symbol distribution is well-known to one skilled in the art where two dimensional constellation has a certain distribution.

Allowable Subject Matter

10. Claims 21 and 25 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

11. The following is a statement of reasons for the indication of allowable subject matter:

Present application discloses a method of binary coded data communication comprising a transmitter further comprising TTCM and shaping elements and dividing a sequence into three parts and processing and mapping the sequences. The receiver further comprises turbo decoder and receiver constellation shaping elements. Prior art teaches or suggests in combination all the subject matter claimed. However, prior art does not teach or suggest in combination de-mapping a first part sequence via a shell de-mapper and mapping the remaining part via symbols to bits mapper, and combining the two parts to recover the sequence at the receiver.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Sam Ahn whose telephone number is (571) 272-3044. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jay Patel can be reached on (571) 272-2988. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Sam K. Ahn
9/8/05